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WINISK RIVER BASIN

(SURFICIAL GEOLOGY)

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INTRODUCTION

Method of Investigation

The hydrogeological investigation undertaken in the Winisk River basin during the summer of 1968 was done by canoe traverses down the Pipestone, Winisk and Ashweig rivers. The writer with one or two helpers travelled over 730 miles on these rivers using either a 16-foot aluminum canoe, or a Hudson Bay 18-foot freighter canoe powered by a 3-horsepower outboard motor. On these traverses several miles of portage had to be cut through dense bush. The Pipestone, Winisk and Ashweig rivers have many rapids throughout their courses and most of them necessitated portages. The step-like profile of the Winisk River precludes its being used as a major water route in northern Ontario.

As the best Pleistocene sections are to be seen along the rivers, mapping was confined mainly to the banks of the rivers where sections were visible due to downcutting of the rivers into the overburden. Where open cuts were not visible, short traverses were made outside of the flood plain of the rivers. Shallow pits were dug to expose part of the soil profile, or shallow holes were bored with a soil auger.

Living accommodation in the field was extremely poor. A small tent was used for shelter. It was necessary to travel with all one's gear and food each day for over three weeks. A new camp had to be established and relocated daily. In order to get an 8-hour traverse completed each day, it was necessary to work for at least an extra three hours to establish camp and pack up the tent and camping gear. The average work day was usually between 12 and 14 hours. During the first two weeks of traverse, approximately 70% of the work day was spent cutting and making portages around rapids.

In addition to mapping the overburden, bedrock was also mapped, although not in detail. The bedrock has not been grouped into definite rock units and precise names for the rocks have not been obtained because this would necessitate preparing thin sections of some rock specimens, and based on past experience, the writer has become aware that any such attempts would be abortive.

Samples of the overburden were collected and sent to the laboratory operated by the River Basin Research Branch, Division of Water Resources, OWRC, for sieve analysis. The results obtained have been poor and in some respects, useless.

Purpose of Investigation

The project was undertaken to determine the extent, limits, and nature of the overburden, and the type of bedrock which constitute the Winisk River drainage basin. The information is to form an integral part of the hydrogeological studies presently being undertaken in the Northern Ontario Water Resources Study.

Area Mapped

The first traverse was started on the Pipestone River at latitude 50°07'N and longitude 91°41'W, and ended on the Ashweig River approximately 10 miles upstream from its confluence with the Winisk River. The traverse was made via Wunnumin Lake, Winisk Lake and the Wye Rapids. All the area downstream from the starting point on the Pipestone River to the point of termination was mapped. Another canoe traverse was made from Kasabonika Lake to Straight Lake, and the third from Kingfisher Lake to Long Dog Lake. The area between Long Dog and Kasabonika lakes was mapped by aircraft traverse. The final traverse was done by boat from Peeagwon Lake to Wunnumin Lake.

Approximately 19,500 square miles of the Winisk River drainage basin was mapped.

Location & Access

Except for the extreme southwestern part, the Winisk River drainage basin (Fig.1) is situated north of latitude 52°00'N. The outlet of the river is on the west side of the Hudson Bay at latitude 55°17'N and longitude 85°07'W. The entire drainage basin lies between longitude 87° and 92° west. Mapping in 1968 did not extend north of latitude 54°20'N.

Scheduled airline flights into some areas in the basin are made once each week during the summer months from Nakina or Pickle Lake, Ontario. These flights are mostly unreliable and most areas can best be reached by chartered float-equipped aircraft from Nakina, Pickle Lake or Moosonee.

CLIMATE

Throughout the Winisk River basin, the winters are severely cold and the summers, mild. There is about 18 to 20 hours of daylight during late spring till mid-summer, but less than 7 hours during mid-winter. Most of the lakes and many of the streams remain frozen from October until June. The climate in the northeastern part of the basin varies slightly from that in the southwestern part. Table 1 gives a brief summary of some meteorological data covering the Winisk River basin and reported by the Meteorological

Division, Department of Transport.

TABLE 1

Mean January daily temperature:	-10 to -20 F
Mean January daily maximum temperature:	0 to - 5 F
Mean January daily minimum temperature:	-20 to -25 F
Mean July daily temperature:	50 to 65 F
Mean July daily maximum temperature:	65 to 70 F
Mean summer rainfall:	5 to 10 in.
Computed maximum snow load:	50 to 60 in. per sq. ft.
Mean annual snowfall:	80 to 100 in.

In the central part of the basin, the mean summer rainfall is approximately 7.5 inches, but this decreases in the northeast to 5 and increases southwest to 10 inches. The figures in Table 1 are based on data collected over a period of 30 years.

GEOMORPHOLOGY

North and east of Straight Lake and Winisk Lake, the Winisk River basin is a flat and almost featureless plain which is covered by thick deposits of peat and muskeg. The drainage is poor and surface storage of water is high — in excess of 80%.

North and east of Winisk Lake all that part of the basin below 600' in elevation is covered by swamps, peat, muskeg and string bogs. These swamps

and bogs are below 500' in the area north and east of Straight Lake. Southeast of Winisk Lake the swamps and bog zones extend to 700' elevation and the string bog limit is much farther south than in the western central part of the basin. Most or all of this zone of swamps and bogs has had the sea overlying it during part of the Quaternary era. The depressions have largely been filled in by marine deposits or by muskeg, so that the land appears to be very flat and featureless.

South and west of the farthest inland encroachment of the sea, and throughout the upper part of the Winisk River basin the area is prominently lineated. This lineation extends as far southwest as Horseshoe Lake. It is a southwesterly trending lineation, formed by streams and the long axes of lakes, eskers, and drumlins and numerous ridges resembling elongated drumlins. Glacial striae also trend southwest in this area. The only prominent features of this area which do not exhibit this southwesterly trend are the recessional or end moraines southwest of Wunnumin Lake. These moraines trend southeast.

South and west of Horseshoe and Stirland lakes and south of Pinemuta Lake, lineations formed by eskers and glacial striae trend easterly. This easterly trending lineation is more prominent in the

Attawapiskat River basin, which is adjacent to the southern boundary of the Winisk River basin.

In that part of the basin southwest of Horseshoe Lake, the land is mostly over 1300' in elevation, but there is no great relief. Several hillocks rise to heights in excess of 100' of the surrounding plain, but none rise to 1500'. Between Horseshoe and Karl lakes, the Pipestone River descends at the rate of almost 9.4 feet per mile, with most of the drop in the last 17 miles. Northeast of Karl Lake, the river descends more gradually as far as Winisk Lake. The general relief throughout most of this part of the Winisk River drainage basin is less than 800' though several peaks rise to over 800' and a few to over 1000'.

Throughout that part of the Winisk River basin south of the Gneiss Rapids, the cover of overburden is relatively thin and seldom exceeds 30'. Along most of this part of the river, outcrops can be seen in the river or along its banks. These outcrops frequently cause rapids.

GEOLOGY OF THE WINISK RIVER BASIN

Historical Geology

The Winisk River basin forms part of a large foreland which almost surrounds the Hudson Bay basin. The upper part of the basin presents no evidence of extensive orogeny since the Precambrian. The lower part of the basin north of the central till plain, in addition to being covered by successive glaciers during the Pliestocene period, has also undergone submergence and emergence from epicontinental seas.

There is evidence of a marine phase followed by two periods of glaciation over that part of the Winisk River basin northeast of the central till plain (Fig. 1). During the latter period of glaciation, there was an interglacial period during which extensive pro-glacial lakes covered the area. Following the retreat of the Wisconsin ice sheet, an epicontinental sea covered the area. The level of this sea pulsated, creating different patterns of sedimentation over the same area. Much of the material deposited over the interior fore-land was transported to the adjacent seas and deposited as the thick beds of sand which cover the Hudson Bay

lowlands at present. In the lower part of the Winisk River basin, clays were deposited simultaneously with sands in the parts closer to the foreland.

As the ice retreated prior to the last marine transgression, an extensive glacial lake, Lake Agassiz, also covered parts of the foreland and left extensive accumulations of clays, silts, and lesser amounts of sands deposited in the lake bed. Smaller proglacial lakes also covered local areas at this time. At the frontal margin of the ice, end moraines accumulated. Inside the ice melt-water channels were filled with fluvioglacial deposits and have formed the eskers existing on the land today.

Precambrian and Paleozoic Geology

The bedrock geology map (Fig. 2) indicates the Precambrian and Phanerozoic geology of the Winisk River basin.

The southwestern till plain is an upland area bounded on the northeast by a prominent end moraine, the Agutua moraine, which trends southeast and transects the Winisk River basin northeast of Stirland and Horseshoe lakes (Fig. 1).

On the southwestern till plain the bedrock as exposed at the surface or underlying the overburden is predominantly granitized to migmatized, leucocratic,

medium grained gneissose or isotripic granitic rocks In some areas the gneiss is either intruded by pink granite or has been intensely migmatized or granitized so that the rock has lost much of its original texture, and has been altered to pink granite. A belt of melanocratic fine grained meta-volcanic and meta-sedimentary rocks ("greenstones") trend northwest, southwest of Stirland Lake and easterly through the northern shore of Kecheokagan Lake.

Northeast of the Agutua Moraine the river basin lies in prominently foliated granite gneiss and medium to coarse grained granite similar to that in the southern till plain. Where the Pipestone River transects the moraine, outcrops of granite gneiss may be seen along the banks of the river. At the western end and outlet of Karl Lake, a belt of meta-volcanic and meta-sedimentary rocks trend northwesterly, northwest of Karl Lake, and easterly to the southeast of the lake. This belt of metamorphic rocks is 1 - 8 miles wide.

Underlying most of the clay belt and the central till plain is quartz-feldspar-biotite-hornblende gneiss. The rock is mostly coarse or medium grained and mesocratic. In several places, it is intruded by pink coarse grained, medium grained, or porphyritic granite

and quartz-feldspar rocks. The gneiss is extensively granitized and migmatized. Granite and severely migmatized rocks are more abundant in the Kingfisher Lake area and in the upper part of the Ashweig River (above Kaneesose Lake) than elsewhere in the area. Within these quartz-feldspar-biotite/hornblende gneisses is a prominent belt of Keewatin sedimentary and volcanic rocks. This belt of rock trend northwesterly across Wunnumin Lake. The rocks include sandstone, conglomerate interbedded tuffs, lavas and metasedimentary rocks, quartzites and schists, plus minor bodies of quartz diorite, gabbro and amphilbolite. The belt of Keewatin rocks is 4½-5 miles wide in the Wunnumin Lake area but it gradually widens to the southeast, to the south of Mameigwess Lake and north of Peeagwon Lake.

The area between the central till plain and the Paleozoic rocks of the Hudson Bay Lowlands is mostly underlain by quartz-feldspar-biotite gneisses, but within the gneisses are bodies of quartz diorite, diorite, granodiorite as well as mafic to intermediate meta-volcanic rocks.

In the Winisk River basin the Ordovician rocks of the Hudson Bay Lowlands belong to the Bad Cache Rapids Group and the Churchill River Group. The

former are predominantly basal sandstone, fragmental limestone, dolomitic limestone and minor chert. The latter group is composed of brown limestone. The Ordovician rocks are overlain by Silurian limestones, dolomites and cherts of the Attawapiskat, Ekwan River, and the Severn River formations. The Silurian rocks are much more widespread than the Ordovician.

Quaternary Geology

Based on its Quaternary geology, and physiography, the Winisk River basin is divided into the following seven subdivisions (Fig. 1):

1) Southwestern Till Plain
2) Rocky Belt
3) Clay Belt
4) Belt of Lacustrine Sands
5) Central Till Plain
6) Southwestern Fringes of the Tyrell Sea
7) Hudson Bay Lowlands

Southwestern Till Plain

The southwestern till plain is an upland area approximately 1680 square miles in extent. It forms the uppermost part of the Winisk River drainage

basin. Most of the area lies above 1300' and some of it above 1400' altitude. The most eastern part of the area is covered by an end or recessional moraine which terminates against the Agutua moraine except in the Lemont Lake area, where a small part of it extends east of the Agutua moraine close to the Attawapiskat-Winisk River divide.

In this area, the record left by glaciers indicates a westerly or west-southwesterly advance of the last glaciers to cover the area. The stream which traverses the area trends and flows north-northeasterly, the major eskers trend easterly and northeasterly, and these directions are also the trend of glacial striae and the long axes of drumlins.

Throughout all of the southwestern till plain, the overburden is shallow and rarely exceeds 10 feet in depth except in the recessional/end moraine, on eskers, and in isolated pockets. Sandy till forms over 95% of the overburden. The till is medium brown in colour with a matrix of medium grained sand. Well rounded quartzo-feldspathic boulders are abundant in the till as well as cobbles and pebbles of fine grained mafic rocks.

The shallow overburden in this area accounts

for the low and rocky banks of both the Morris and Pipestone rivers, which are the rivers in this area, and along the lake shores. Granite, granite gneiss, migmatite and "greenstone" crop out through the overburden all over the till plain.

The vegetation is luxuriant because of the well drained nature of most of the area. There are peat bogs and muskeg, however, but these are not thick and their presence is due to the fact that the water table is close to the surface in the flat areas where they are present. The large vegetation is predominantly Pinus banksiana sp. Lamb., Picea glauca (Moench) Voss, Betula patyrifera Marsh., Populus tremuloides Michx, and Populus balsamifera L.

Surface storage, that is, open water in this area, is between 10-15% of the area. Both the Morris and Pipestone rivers are fast flowing across the southwestern till plain, and the numerous outcrops in the rivers give rise to much turbulence and many rapids.

Rocky Belt

The rocky belt is that area to the north and south of Opapimiskan Lake, and northwest of Lemont Lake. It forms a constriction in the Winisk River basin. The area is predominantly rock outcrop with minor sandy till or clay, or lacustrine sands.

The rocks have several lineaments and faults cutting them and many of the larger depressions are filled by lakes with rocky shorelines. Where the Pipestone River crosses the rocky belt, the river flows along a major lineament. The river is exceedingly turbulent throughout all of this belt because within a distance of 30 miles it drops over 250', flowing over bedrock throughout most of this distance.

The area of the rocky belt is approximately 540 square miles. The vegetation is largely Pinus banksiana sp. Lamb, Picea glauca (Moench) Voss, with lesser Betula patyrifera Marsh, Populus tremuloides Michx, and Populus balsamifera L.

Agutua Moraine

A prominent recessional/end moraine - the Agutua moraine, transects the upper Winisk River basin in the vicinity of Horseshoe and Stirland lakes. It trends northwest across the basin, forming a prominent ridge system which was heavily forested. The moraine also transects the Severn River basin to the north and the Attawapiskat River basin to the south of the Winisk.

The Agutua moraine is composed predominantly

of coarse to fine grained medium brown sand in which large well rounded to angular boulders of igneous and metamorphic rocks are interspersed. Some of the boulders are several feet in diameter. The moraine has the physical characteristics of sandy till. A relatively minor fraction of the material comprising the moraine is finer than medium grained sand. Prominent wave cut platforms and lake terraces are present in the moraine, and erratics are common also. Much of the finer and finest particles of the moraine has been winnowed or washed out and presently forms outwash which flanks the axial part of the morainal ridge. On the southwest side of the ridge there is a narrow shoestring zone of clay at the most outward border of the moraine complex. This belt of clay grades into silt, which grades into fine sand towards the morainal axis. The zone of fine sand in turn grades into a zone of medium and fine grained sand. All these flanking deposits are well sorted. Even some of the sands on the terraces along the morainal ridge appear to have undergone some sorting.

The sequence represented on the southwestern side of the ridge is repeated on the northeastern side with the exception of the zones of clay and silt.

Because of the extremely porous well drained nature of the soil in the moraine, the area is densely forested with large timber and thus forms a striking contrast with the surrounding forests, with their much smaller trees. Where the Pipestone River truncates the moraine, the latter rises to over 150' above the river. The till comprising the moraine is thus about 150 feet thick.

The Agutua moraine complex - till and outwash - cover approximately 325 square miles of the Winisk River basin.

Clay Belt

Within the Winisk River basin the clay belt covers an area of over 2,103 square miles south of Wunnumin Lake and north and northwest of Pinemuta Lake. It trends across the basin into the Attawapiskat basin and into the Severn River basin where most of the clayey zone lies.

The clays are lacustrine and in some places they are varved and in others, isotropic. They are mostly pale brown, brown-grey, pale yellow-brown or dark brown. Varved clay is extensive within this belt and exhibits alternating pale brown and dark brown layers of less than 1/16 to over 2 inches in thickness from one locality to another. At some scattered loc-

alities, silt is more predominant than clay. The clay does not form nearly as thick deposits as it does in the Severn River basin where sections 30-50 feet thick can be seen. In the Winisk River basin, the clay has not been observed to exceed 10 feet in thickness in any sections, although several hillocks and mounds which rise 20 to 40 feet above the local topography are covered with clay, the thickness of which is unknown. Throughout most of the length of Peeagwon Creek and the section of the Pipestone River between Karl Lake and Misamikwash Lake, the clay can be seen overlying quartzo-feldspathic gneisses or "greenstone".

South of Wunnumin Lake and on the northwestern fringes of the clay belt, the clay becomes increasingly silty and a narrow zone of silt at some places forms the transition zone between sandy till, lacustrine sands and clay.

In the Winisk River basin most of the clay belt lies over 900 feet above sea level and constitutes a flat swampy plain from which many small knolls rise. These knolls are heavily forested and frequently give rise to local relief of 100 feet or more. On slopes and near the banks of rivers, the clay is well drained and gives rise to tall forests of Abies balsamea (L.) Mill, Populus tremuloides Michx, Populus balsamifera

(L.), Picea glauca (Moench) Voss, and Betula patyrifera Marsh. Pinus Banksiana sp. Lamb. sometimes grows in the clay belt where the drainage is extremely good, and the soil is not deep or on rocky ledges in the clay.

Where the clay is subjected to frequent wetting and drying, it undergoes a change in texture. The clay usually becomes pale black or chocolate-coloured and particles aggregate to form small, irregular but angular grains similar to coarse sand and/or medium pebbles. The soil is therefore rendered pervious.

Lakes in the clay belt have a distinctive appearance. The lake waters have a pale brown colour because of fine particles of clay suspended in the water.

Within the clay belt are several eskers. Some of these are overlain by a thin veneer of clay, whereas others appear not to have been completely submerged by the lacustrine waters which gave rise to the clay deposits. These which were not completely submerged have sand, sandy till, or gravel exposed at the surface along their axis.

Belt of Lacustrine Sands

A belt of lacustrine sands and silt lies between the northern boundary of the clay belt and the

central till plain. This belt is over 600 square miles in extent. The sands are distinctly bedded, medium brown in colour and well sorted. They range from coarse grained to very fine grained and in some places are predominantly medium to coarse silts.

The contact between the lacustrine sands and the lacustrine clays has not been observed in the field. It is assumed that the clays and sands are of the same age and represent different facies or depositional environments within Lake Agassiz. Where they are in contact with the sandy till, both the clay and the lacustrine sands overlie the sandy till.

The very permeable nature of the overburden within this belt results in well drained soils over the area, which is consequently occupied by tall forests of Pinus Banksiana sp. Lamb., Betula patyrifera Marsh., and Populus tremuloides Michx. The overburden is thin and rarely exceeds 10 feet except in depressions. Rocky protrusions through the sands are numerous.

This is an area of moderate to low relief with most of the land surface above 900 feet altitude but below 1000 feet. Surface storage is approximately 15 per cent.

Central Till Plain

The area herein called the central till plain is one which covers approximately 9,620 square miles and extends from the southeastern extremity of the Winisk River basin, east of Mameigwess Lake to west of the Ashweig River and north of Kasabonika Lake. Its northern and eastern extent is formed by the strandline which marks the farthest inland extent of the Pleistocene and Recent seas to cover parts of the Hudson Bay-James Bay lowlands.

Quaternary glaciation has left pronounced imprints in the bedrock and in the sandy till which covers the bedrock of the central till plain. Well defined furrows and grooves alternate with low ridges throughout almost all of the area, although these are more pronounced in the eastern part of the plain. The furrows and ridges present a relief of 50 to 150 feet. They trend northeast and determine the axes of streams and lakes in the area. Many of the furrows have been flooded to form lakes such as Kasabonika, Winisk, Chipai, Shibogama, and Mameigwess lakes. These lakes contain many elongate islands formed by sandy till and/or bedrock. The ridges and islands are in fact elongate drumlins and drumloid features. The overburden on them is often shallow but accummulations of sandy till may

be 30 or 100 feet thick over the crest of the hills. The axes of these hills coincide with those of the eskers and streams located in the area.

The area is overlain by sandy till which is from zero to 100 feet deep. Bedrock crops out on very few ridges, and even in many of the furrows bedrock is not obvious, although huge boulders are often present. These boulders range from angular to rounded and tend to accumulate about the peripheries of the lakes.

The water table is close to the surface throughout most of this zone and almost all of it is overlain by varying thicknesses of muskeg, some of which remains permanently frozen and thus create artesian conditions in the overburden. Swampy areas in the central till plain are largely due to muskeg and a high water table. The water in these swamps is usually not stagnant because of free groundwater movement in the highly permeable sandy till.

On some of the ridges and local areas where the soil is better drained, Betula patyrifera Marsh., Populus tremuloides Michx., and Populus balsamifera L., are abundant, whereas over the remainder of the area, the predominant vegetation is Picea (mariana) Mill (B.S.P.).

Small areas of lacustrine sediments (sands and/or clay) are present within the central till plain. These are probably due to small proglacial lakes which were of local extent only.

The central till plain is an area of moderate relief, and is tilted gently to the northeast. Along the southern boundary the land is mostly at about 800 feet elevation. A small area northeast of Kingfisher Lake is over 900 feet, but most of the northern part is close to 600 feet above sea level. Open water occupies 20 to 25 per cent of the total area.

The sandy till overlying the central till plain is medium brown in colour, but the uppermost two to six inches is frequently bleached to pale grey. Fine or medium grained sand forms the bulk of the till but pebbles, cobbles and boulders of varying sizes and composition may be present. South of the central part of the area limestone fragments have not been observed in the till, but to the north of here the till becomes increasingly calcareous as the northern extent of the zone is approached.

Southwestern Fringes of the Tyrell Sea Floor

An area of approximately 2,950 square miles lies between the Precambrian-Paleozoic contact and

the most southwesterly extent of the Tyrell Sea over the Winisk River basin. As may be seen from the accompanying map, most of this area has glacial material covering it, but there are also areas covered by marine clay, sand and silts as well as a small rocky area with only minor quantities of Quaternary sedimentation.

The area is one of very low relief and its Pliestocene geology is largely similar to that in the southwestern part of the Hudson Bay lowlands.

In the area north of Prime Lake, thick deposits of silty till are exposed on the Tyrell Sea floor. The till is pale brown or grey-brown in colour, and is made up of approximately 90 per cent silt and very fine sand, with mixed quantities of coarse sand, granules and pebbles. Granules up to one inch in diameter are common in the till but boulders are very rare. At a few localities, boulders up to one foot in diameter have been observed in it. Well rounded fragments of limestone, as well as fine grained mafic rocks and granitoid rocks are common in the till.

Several sections from 2 to 40 feet thick have been observed overlying granitoid quartzo-feldspathic rocks. In the Winisk River basin as well as in the Severn River basin, this silty till is divided into two parts. A bed of pale brown very fine grained to medium

grained well sorted sand constitutes the division between the upper and lower parts. The upper and lower parts appear identical in colour, texture and composition. The sands which divide them show good cross bedding and vary in thickness from 8 inches to one foot. Pelecypods have been found in these sands. These crossbedded sands are overlain by about 5 feet of silty till near the Sea Shell Rapids on the Winisk River but are overlain by approximately 15 feet of silty till near Fort Severn in the Severn River basin.

The silty till on the Tyrell Sea floor differs from other tills in the Winisk River basin by its colour, its texture and its composition.

Along the banks of the Winisk River, there are sections exposed where this silty till rests upon a blue-grey semi-consolidated silty-clayey till. This blue-grey semi-consolidated till has only small and limited exposures in the southwestern part of the Tyrell Sea floor in the Winisk River basin. In spots near the northeastern boundary, the silty till is overlain by a few inches of medium and fine grained crossbedded or graded-bedded sands.

The area adjacent to the Wye Rapids and the northern part of Straight Lake is covered by a pale green-grey or pale olive-green marine plastic clay.

In these areas, the clay underlies two to five feet of muskeg, the lower one to two feet of which is permanently frozen. The clay is generally devoid of sand or silt size fractions. Only at a single locality (south of the Wye Rapids), has it been observed to be silty, and here its colour is mostly pale grey with only a slight green tinge. Near Straight Lake, the clay is partly overlain by the typical medium brown sandy till of the central till plain.

The muskeg which covers the southwestern part of the Tyrell Sea floor supports forests of Picea (mariana) Mill (B.S.P.). The trees tend to be shorter, smaller and more scattered than those farther south. In the more swampy parts, tamarac is also present. Much of the area is covered by string bogs. The southern limits of string bogs over the Winisk River basin is shown on the accompanying map (Fig. 1).

In parts of the area south of the Precambrian-Paleozoic border, marine sands several feet thick form the superficial cover. These parts are described under the section, "Hudson Bay Lowlands".

Hudson Bay Lowlands

In Canadian geological literature, the area referred to as the Hudson Bay lowlands is that part of

the country which is adjacent to the Hudson Bay and the overburden (if any) which covers it rests upon rocks of Paleozoic age. The only exception to this is where older sedimentary or igneous rocks form inliers within the Paleozoic sedimentary succession. The Quaternary geology of this region, however, is the same as that of parts of the area south of but adjacent to the trace of the unconformity which is at the contact of the Precambrian and Paleozoic rocks. Consequently, in this report where the southwestern part of the Tyrell Sea floor is covered by thick deposits of marine sediments similar to those in the Hudson Bay lowlands, it is included under the section, "Hudson Bay Lowlands".

In the Winisk River basin the Hudson Bay lowlands is an area of exceedingly low relief occupying approximately 8,906 square miles. More than 95 per cent of this area is less than 500 feet altitude. All of the area is occupied by swamps or string bogs, except for about 50 to 300 feet inland from the banks of some of the major streams. Along the streams, the narrow well drained area supports tall Populus tremuloides Michx, Populus balsamifera L., and Picea glauca (Moench) Voss. The rest of the area is almost devoid of trees.

Usually about 6 to 20 feet of muskeg overlies the surface in the poorly drained parts, and 3 to 10 feet in the better drained parts.

The Quaternary sedimentation on the Hudson Bay lowlands represent successive transgression and regression of the ocean, the last of which was the Tyrell Sea. In addition, there have been at least two glacial periods with their consequent sedimentation, and interglacial periods when fresh water lakes covered large parts of the area. As indicated by raised beaches, the trangressions and regressions have been from the north and east. The sedimentary succession therefore represent some onlaps and off-laps in different parts of the Hudson Bay lowlands. Consequently, the unconsolidated sedimentary units represented at one place in the Hudson Bay lowlands within the Winisk River basin are not to be encountered at all places in the lowlands. Some of these units lens out or wedge out southward and westward, and become underlain or overlain by other units as the Hudson Bay-James Bay basin is approached.

The uppermost layer of Quaternary sedimentation in the Hudson Bay lowlands is represented by marine sands and silts (Fig. 3). In the upper part of the lowlands, the sedimentation represent fluctuating sea-levels

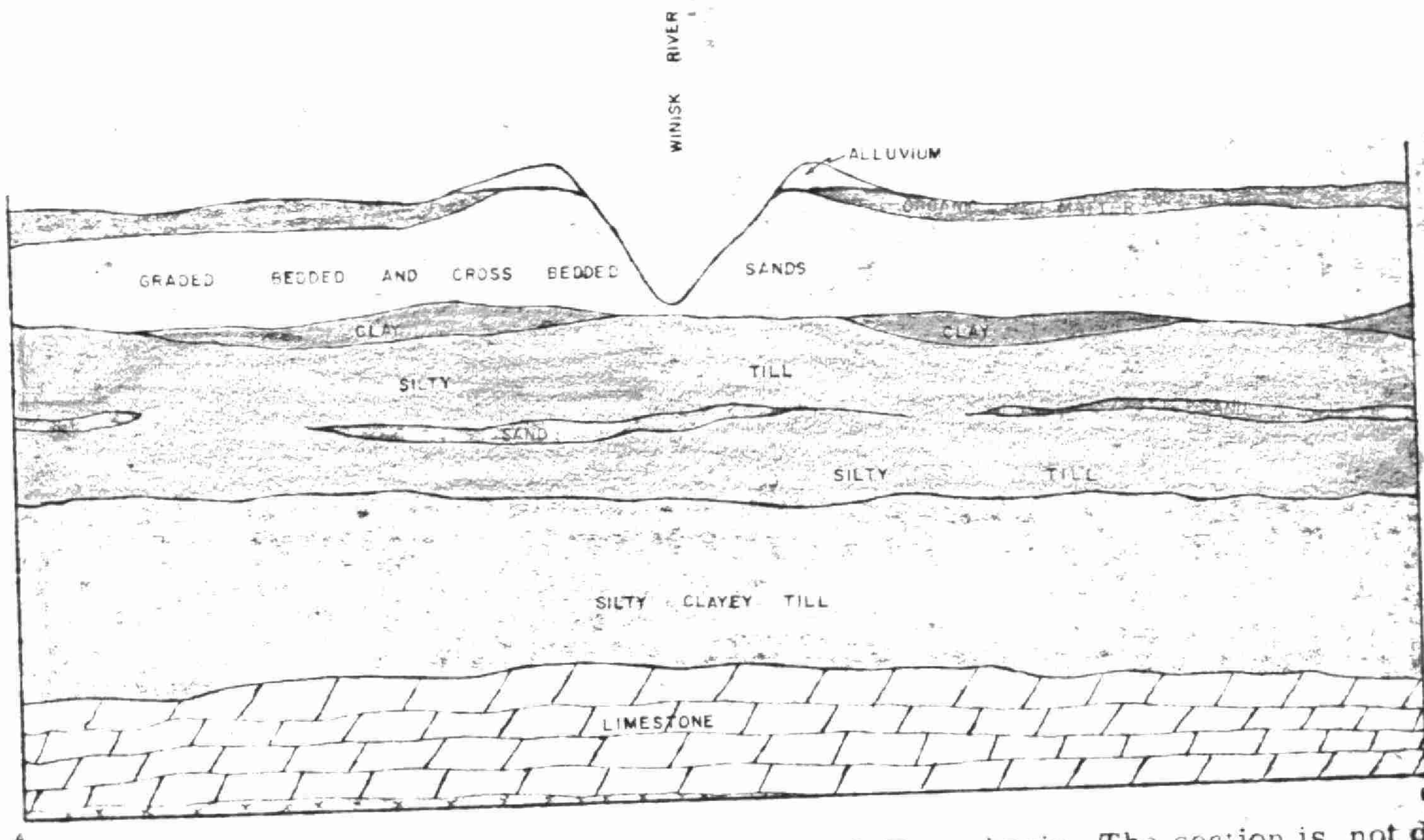

Fig. 3. Transverse section A-B (Fig. 1), across the Winisk River basin. The section is not drawn to scale.

during deposition. Above the upper silty till (page 25), are several layers of pale brown to medium brown fine to coarse grained sand. The sands show graded bedding in some beds, and cross-bedding in others. Some layers are well sorted, others are poorly sorted. The variations to be seen in a single section of 10 to 40 feet are numerous due to the pulsating sea levels over the area during the Quaternary era. The area from the Precambrian-Paleozoic contact as far north as the confluence of the Ashweig and Winisk rivers has at the top of the section, very fine grained well sorted sands and silt, 2 to 10 feet thick. Near the village of Winisk not far from the Hudson Bay, a similar layer is present at the uppermost part of the section. Below these fine grained sands are the graded bedded and the cross bedded sands comprising a section of varying thickness. Sections of 5 to 7 feet are common. These sandy layers contain many fossils - corals, gastropods, and pelecypods.

Underlying the marine sands is glacial till similar in appearance and composition and equivalent to the silty till described in the previous section (page 24). This is usually 6 to 8 feet thick and is underlain by the lower semi-consolidated pale olive-green or green-

grey silty and clayey till. The contact between these two tills is gradational over 2 to 4 inches and is very prominent due to the remarkable differences in the colour of the two.

Although silty, the upper till contains very little clay and so is permeable. The lower till, however, contains approximately 26 per cent silt and clay size fraction, of which much of this is clay. It also contains may pebbles, but few boulders or cobbles. It is relatively impermeable with respect to the upper till, and at many places ground water discharge takes place near the interface between the two tills. It has not been possible to determine the thickness of the lower till because the base of it has not been seen in the Hudson Bay lowlands.

Near the village of Winisk a marine clay is sandwiched between the marine sands and the upper silty till. The sediments are of undetermined thickness in this area.

Although the amount of water in open surface storage in the Hudson Bay lowlands appears from maps and air photographs to be approximately 12 per cent, close examination of the area on foot or from a low flying aircraft in sunny weather will reveal that there is over 90 per cent open storage. The areas covered by

muskeg are also saturated with water.

A permanently frozen layer is present in the muskeg. This layer impedes the downward movement of groundwater into the permeable marine sands, hence the presence of extensive swamps and string bogs over the lowlands. Near the streams where the muskeg is thin, this frozen zone extends down into the fine grained marine sands. Below the frozen zone there is free movement of groundwater. The frozen layer acts as an aquiclude and when it is perforated by a drill or soil auger, the water often rises several inches in the hole and sometimes even wells up to the surface.

Raised beaches are a prominent feature of the Hudson Bay lowlands. These beaches are heavily wooded because they stand above the surrounding topography and are better drained. The beach ridges may stand only two to three feet higher than their surroundings but this apparently is sufficient to stand out in this exceedingly flat featureless terrain.

Minor Moraines, Eskers, Drumlins

In the northwestern extremity of the upper Winisk River basin, the southernmost extent of the Sachigo interlobate moraine is present. In this area the moraine no longer stands out as a ridge as it does

in the Severn River basin, but it is still composed of sandy till. North of the Agutua moraine, two end moraines trend northwesterly. Each moraine is not continuous but there are short breaks in each. These moraines are composed mainly of material similar to sandy till. One is north of Kingfisher Lake and the other south of the same lake. Another moraine of similar trend is southeast of Opapimiskan Lake but this moraine is a DeGeer moraine. Some of it occupies part of the clay belt whereas the northwestern part of it rests largely upon outcrop.

Numerous eskers of varying lengths and heights are present in that part of the Winisk River basin underlain by Precambrian rocks. All of the eskers trend northeasterly with the exception of those in the southwestern till plain. The eskers are mostly sandy to cobbley but some of them contain silty and clayey parts. Being well drained areas, the eskers are all heavily covered with mixed forests.

Most of the eastern part of the central till plain constitute an extensive drumlin field. Some of these elongated drumlinoid forms which constitute the field are several miles long. Almost all of them are composed of sandy till. Typical drumlins are present in the western part of the till plain.

RECOMMENDATIONS

1. The 16-foot aluminum canoe used during the first traverse proved to be very unstable and too low. There was only 4 or 5 inches freeboard below the gunwale. The canoe is wholly unsuitable for even slightly turbulent water either in lakes or rivers. It is suggested that this canoe be used for stream gauging and that a heavier freighter canoe be procured for stream traverses.

2. A light portable two-way radio should be part of the standard equipment for crews left in the bush on their own for more than 2 or 3 days. In the event of an emergency, they should be able to contact someone out of the field to relay messages for help.

3. Besides being inconvenient, extremely annoying and time-consuming, moving of camp each day is laborious. Camps should therefore be established in one place for 2 to 3 weeks and the surrounding area mapped using helicopters or fixed wing aircraft (depending upon the nature of the terrain), to put out and pick up mapping crews each day. Similar arrangements are being used by private companies, the Department of Mines, Energy and Resources, and the Ontario

Department of Mines. This arrangement would probably require combining geological field parties in order to make more efficient use of the aircraft.

4. During the earlier part of the summer, the writer found that moving camps, cutting portages and portaging gear occupied approximately 80-90 per cent of each day's work. This arrangement leaves the geologist insufficient time to do geology. It is recommended that useful and adequate number of helpers be employed to assist in the non-geological part of the work.

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HUDSON BAY
LEGEND
FLUVIATILE
11 ALLUVIAL DEPOSITS
MARINE
HUDSON BAY LOWLANDS
8 SAND
7 CLAY
LACUSTRINE
10 SAND
9 CLAY
GLACIAL & FLUVIO-GLACIAL
6 ESKER
5 SANDY TILL
4 SILTY TILL
3 INTERLOBATE MORAINE
2 END MORAINE, RECESSIONAL MORAINE
1 AREAS WITH EXTENSIVE BEDROCK EXPOSURE
DRUMLIN
DIVIDE, COASTLINE
APPROXIMATE CONTACT BETWEEN SURFICIAL DEPOSITS
FAULT, LINEAMENT
GLACIAL STRIAE
PRECAMBRIAN - PALEOZOIC BOUNDARY
RAISED BEACHES
STRING BOG BOUNDARY
PLEISTOCENE GEOLOGY
WINISK RIVER BASIN
ONTARIO
5 10 15
SCALE IN MILES
REVISED OCTOBER 1968
SEVERN RIVER BASIN
ATTAWAPISKAT RIVER BASIN
ALBANY RIVER BASIN

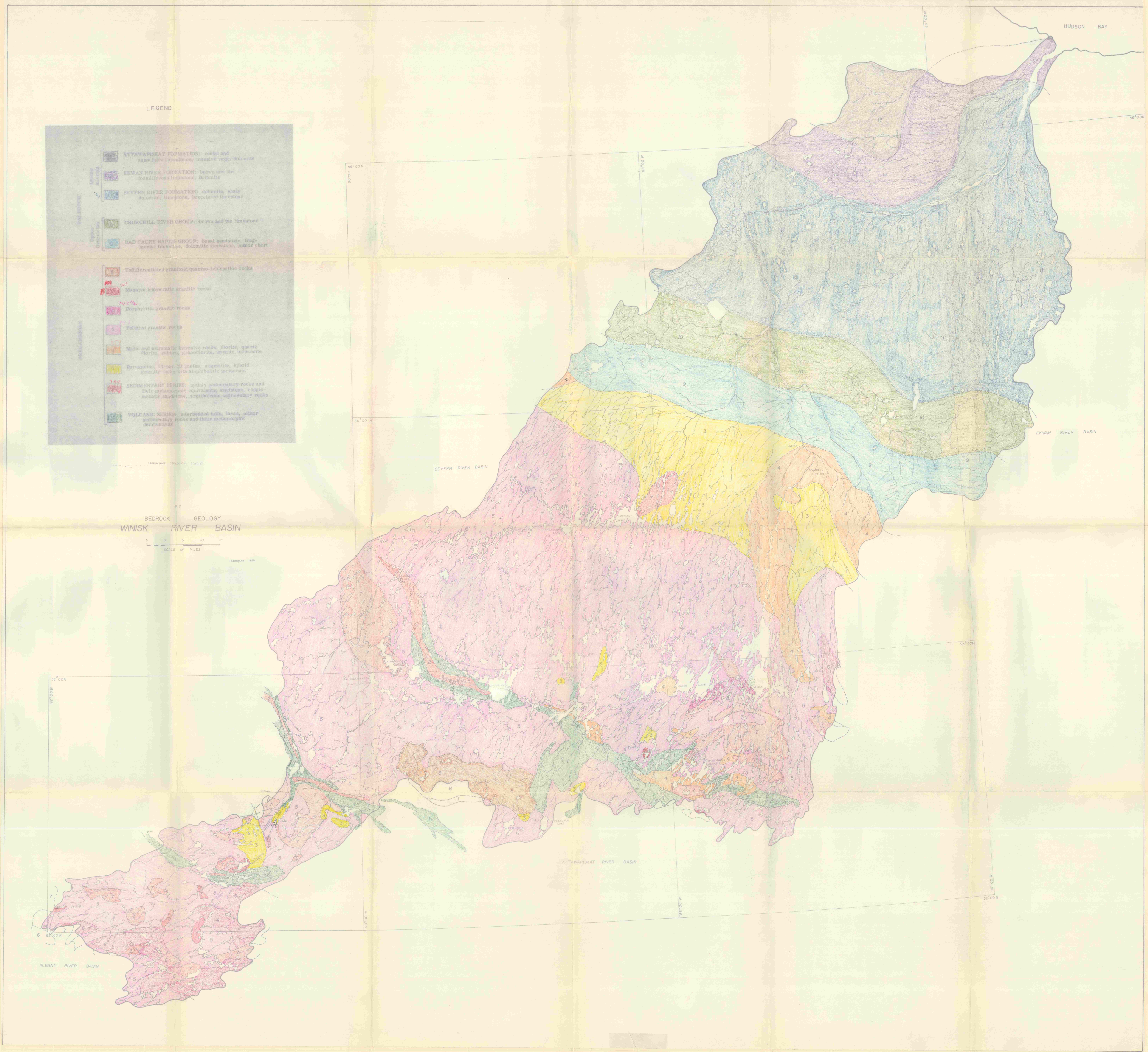

FIG.

BEDROCK GEOLOGY

WINISK RIVER BASIN